
WANDA
Deltares
WANDA user conference
4 March 2010
WELCOME


WANDA
Deltares
Wanda 4 Liquid
Kees Kooij

Wanda 4 Liquid

- What is new
- What has been changed
- What has been left unchanged

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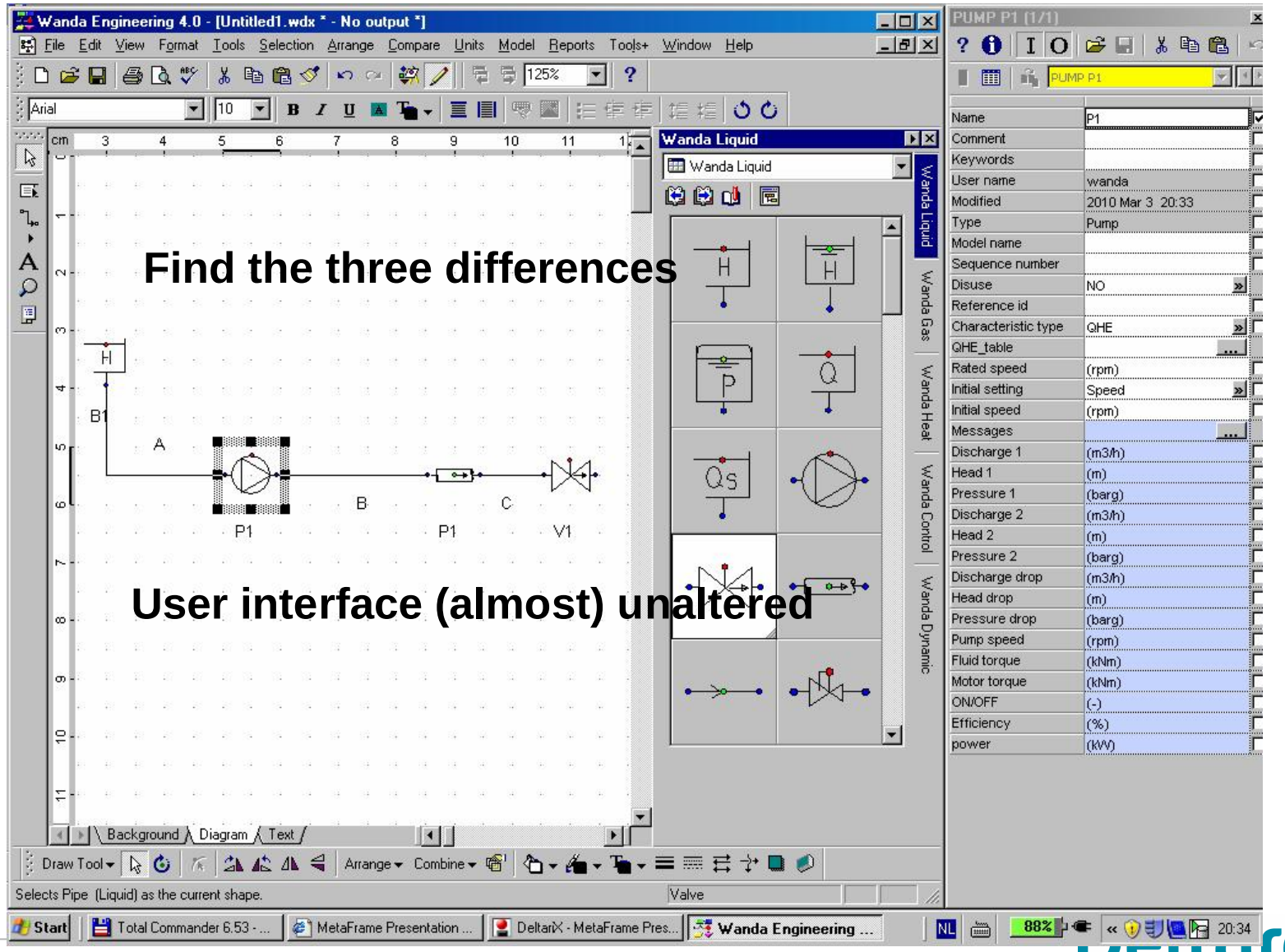
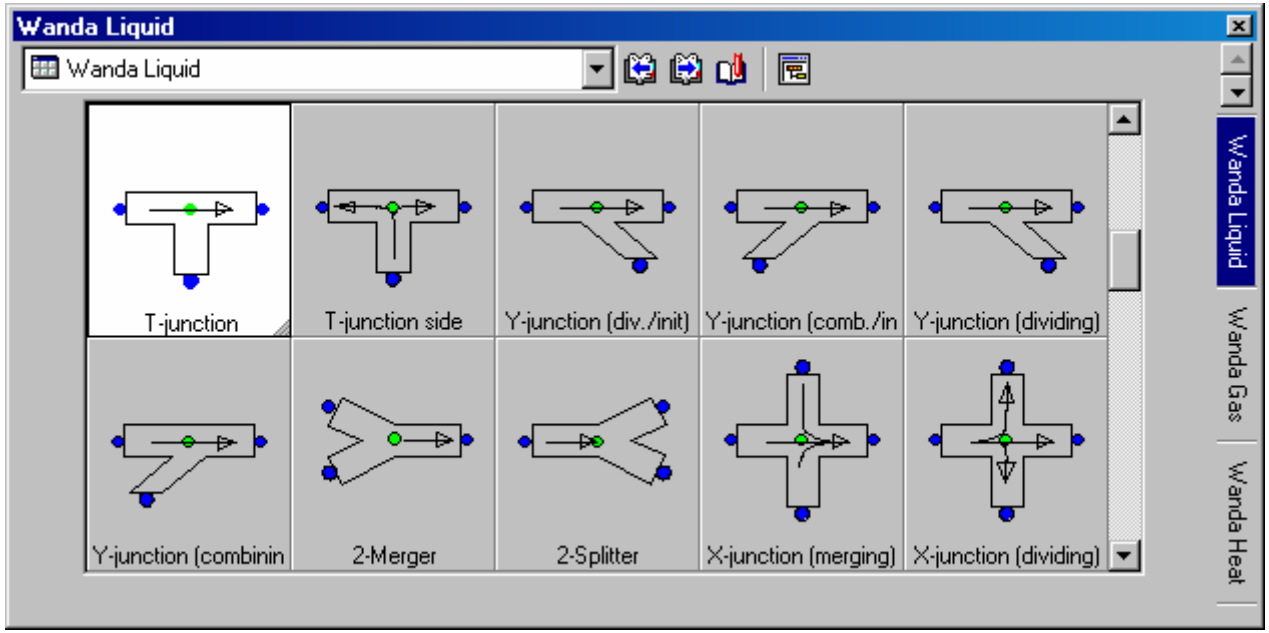
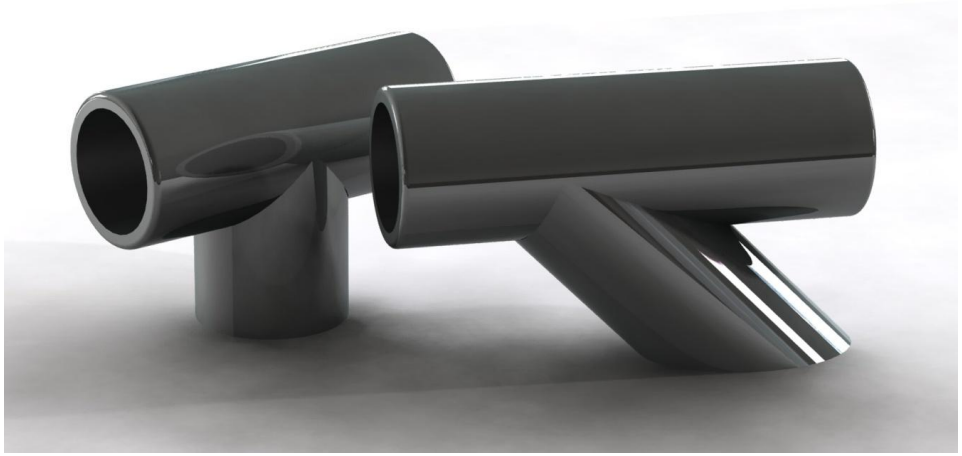
Wanda 4 Liquid - GUI



Wanda 4 Liquid - new

3 and 4 node components





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Wanda 4 Liquid - new

3 en 4 node components

- Complex resistance model
- Local losses depend on ratio of areas and ratio of discharges
- Formulas en tables in handbooks (Idelchik, Miller)

In WANDA 3 essentially not possible to calculate correctly
(determine iteratively)
In WANDA 4 correct calculation of resistances

- Fast
- In time simulation continual recalculation of coefficients with actual Q

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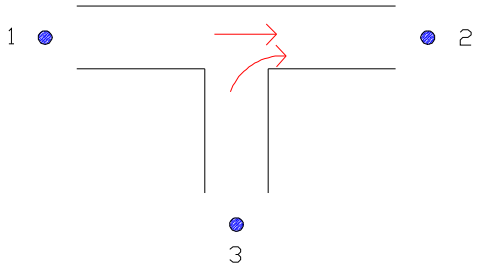
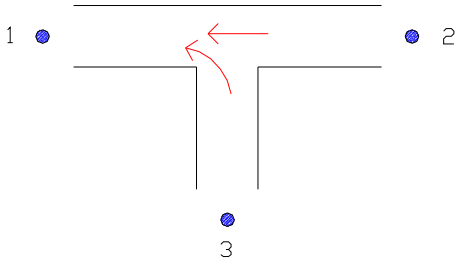
T – Junction

Positive flow

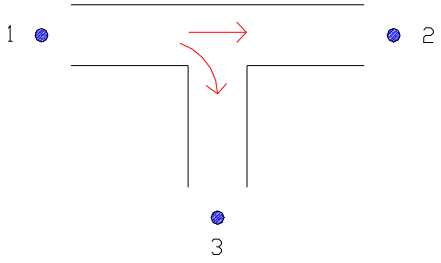
Negative flow

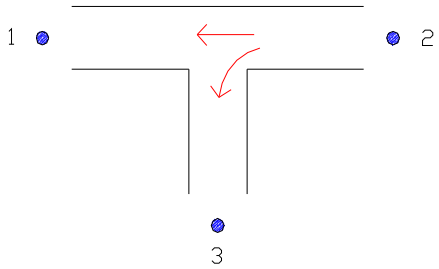
1) *COMBINING*



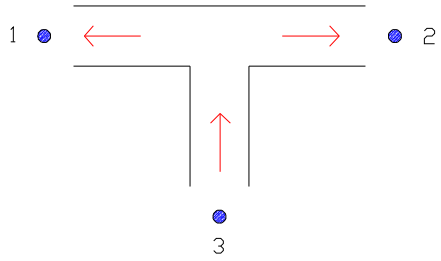


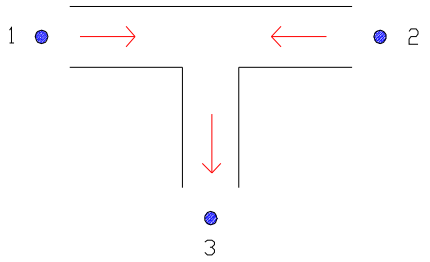
2) *DIVIDING*





3) *UNKNOWN*





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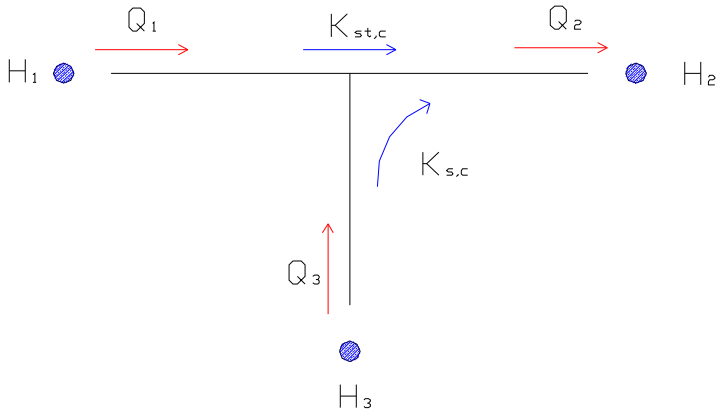
T – Junction – combining flow

POSITIVE FLOW

Straight branch *Combined branch*



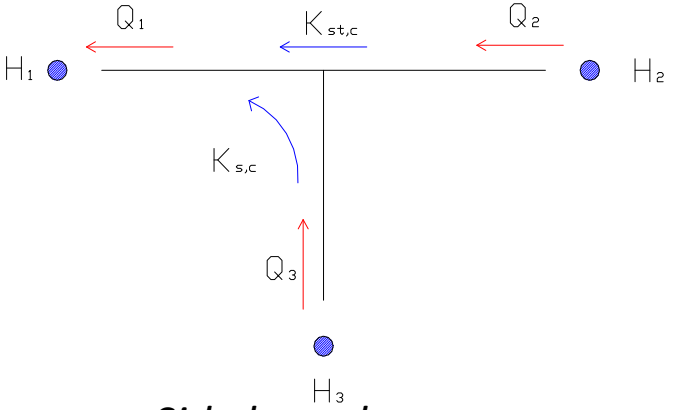
Side branch

Continuity equation:
- $Q_1 + Q_3 = Q_2$

Head loss:
- $H_1 - H_2 = K_{st} (w^2_2/2g)$
- $H_3 - H_2 = K_s (w^2_2/2g)$

NEGATIVE FLOW

Combined branch *Straight branch*



Side branch

Continuity equation:
- $Q_2 + Q_3 = Q_1$

Head loss:
- $H_2 - H_1 = K_{st} (w^2_1/2g)$
- $H_3 - H_1 = K_s (w^2_1/2g)$

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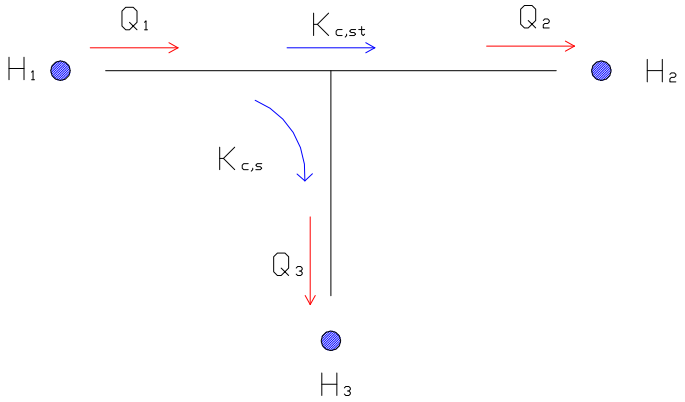
T – Junction – dividing flow

POSITIVE FLOW

Combined branch *Straight branch*



Side branch

Continuity equation:

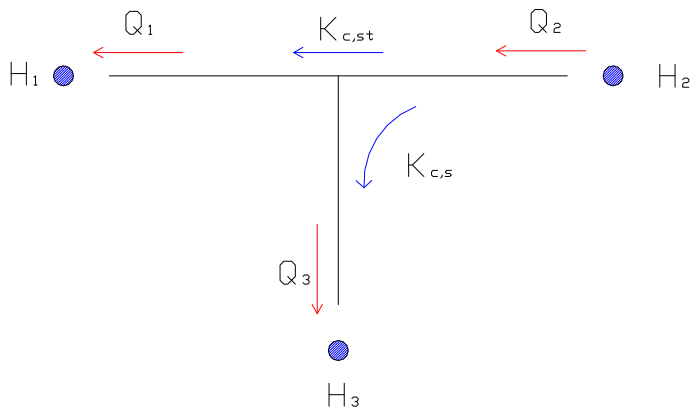
- $Q_2 + Q_3 = Q_1$

Head loss:

- $H_1 - H_2 = K_{st}\ (w^2_1/2g)$
- $H_1 - H_3 = K_s\ (w^2_1/2g)$

NEGATIVE FLOW

Straight branch *Combined branch*



Side branch

Continuity equation:

- $Q_1 + Q_3 = Q_2$

- $H_2 - H_1 = K_{st}\ (w^2_2/2g)$
- $H_2 - H_3 = K_s\ (w^2_2/2g)$

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T – Junction – loss coefficients

IDELCHIK HANDBOOK

1. COMBINING

Straight passage: $K_{st} \approx 1.55\frac{Q_s}{Q_c} - \left(\frac{Q_s}{Q_c}\right)^2$

Side passage: $K_s = A\left[1 + \left(\frac{Q_s}{Q_c}\frac{A_c}{A_s}\right)^4 - 2\left(1 - \frac{Q_s}{Q_c}\right)^4\right]$

2. DIVIDING

Straight passage: $K_{st} = \tau_{st} \cdot \frac{Q_s}{Q_c}$

Side passage: $K_s = A'\left[1 + \left(\frac{Q_s A_c}{Q_c A_s}\right)^2\right]$

- A_s = Area of the side branch;
- A_c = Area of the combined branch;
- Q_s = discharge in the side branch;
- Q_c = discharge in the combined branch;
- A, A’ and τ_{st} functions of Q_s,Q_c,A_s,A_c

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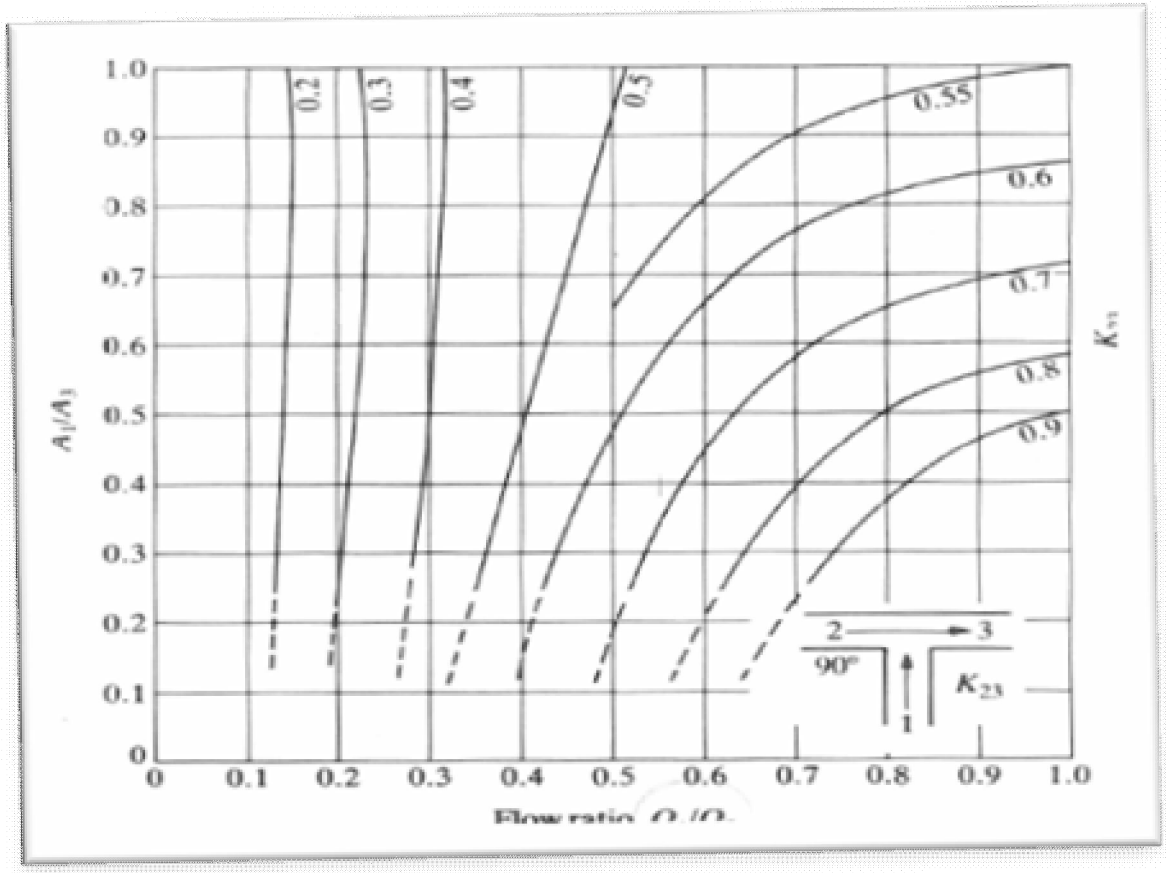
T – Junction - loss coefficients

MILLER HANDBOOK



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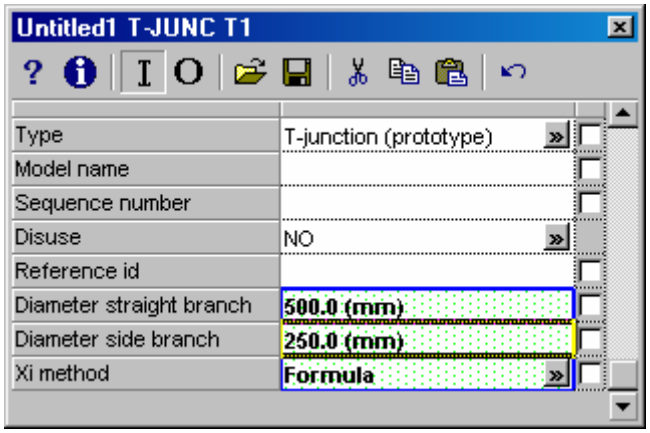
T – Junction

Input parameter: formula / table (Idelchik, Miller or other)



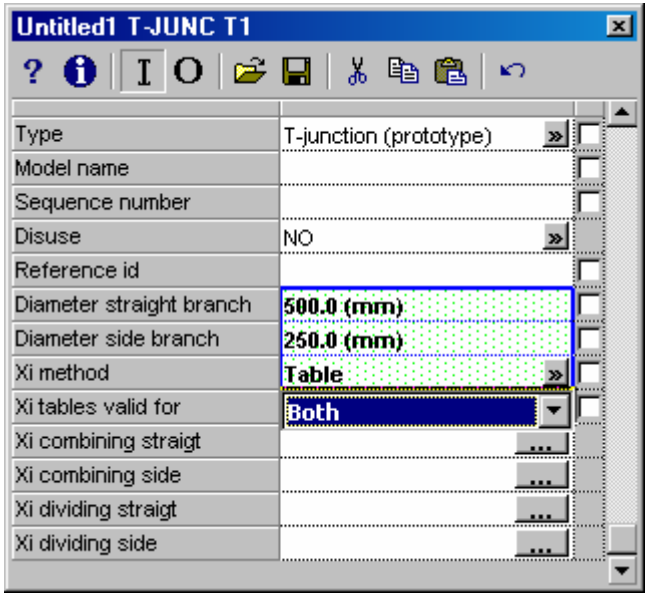


Table: Combining / Dividing / Both

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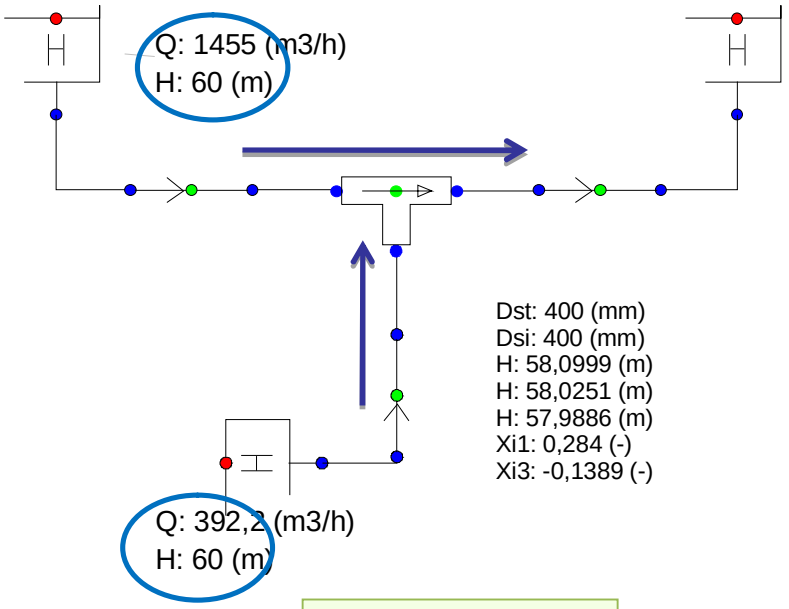
T – Junction - test results

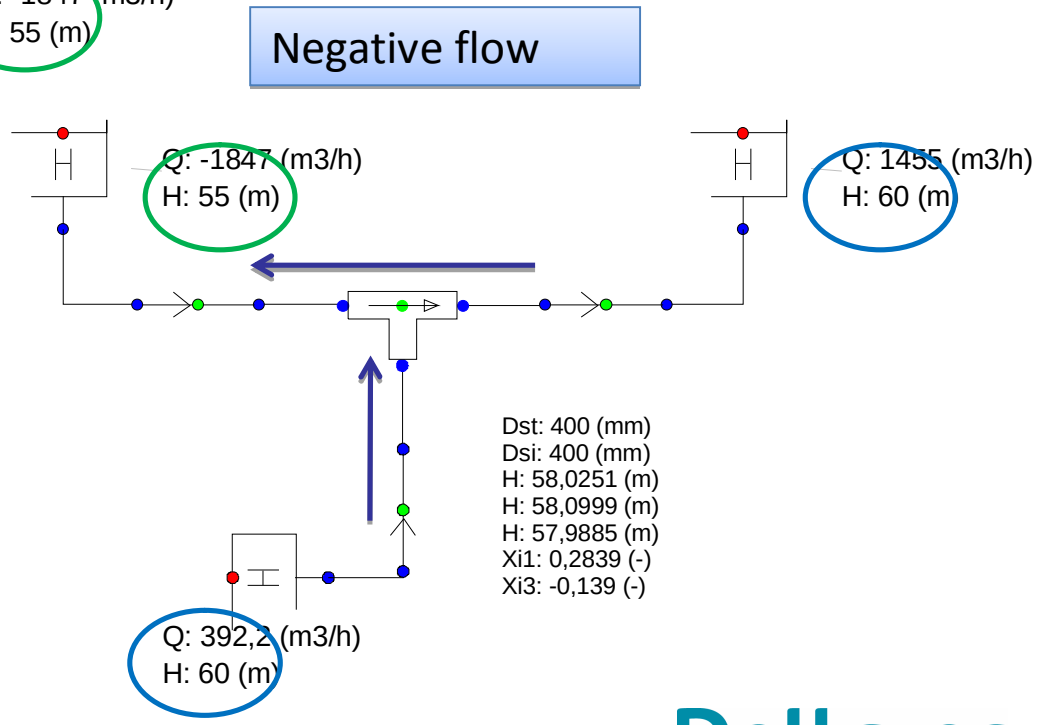
Positive flow



$K_{straight} = 0,28$

$K_{side} = 0,139$

Negative flow



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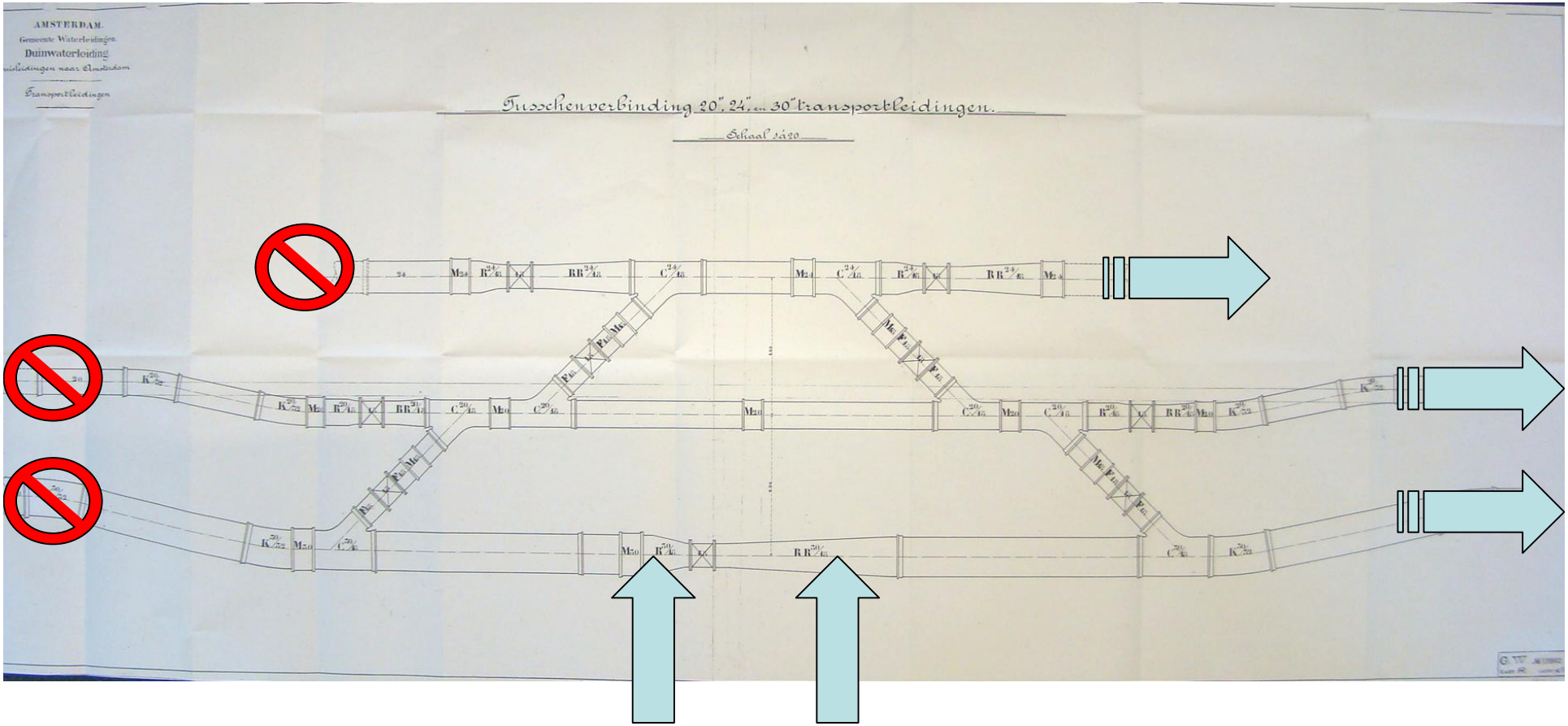
T- Y – Junction - application



New connections

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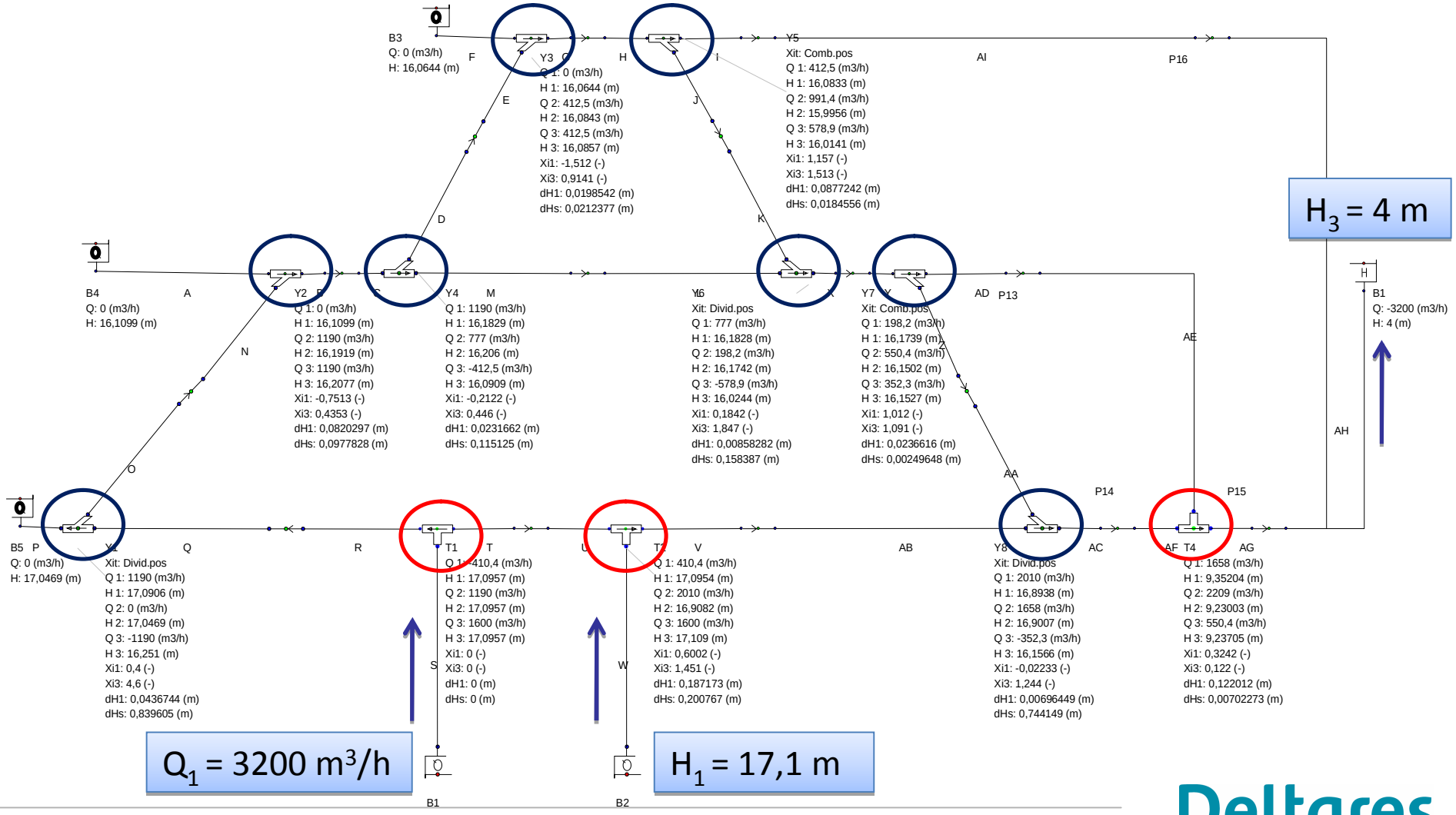
T- Y – Junction - application

H_2 = 16 m → DH = 1,1 m



Q_1 = 3200 m³/h

H_1 = 17,1 m

H_3 = 4 m

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Wanda 4 Liquid – “all in one” PIPE

Wanda 3 several “water hammer” PIPEs:

PIPE – rough	input: k-value
PIPE – lambda	input: lambda
PIPE – xi-losses	input: k-value + table extra losses ksi
PIPE – eq.D	input: k-value + table extra losses L_eqD

for. EPANET import

PIPE – Epanet	choice between several resistance models:
	Darcy-Weisbach (k-value)
	Chezy-Manning
	Hazen-Williams

for advise project:

PIPE met bi-directional extra local losses (ksi)

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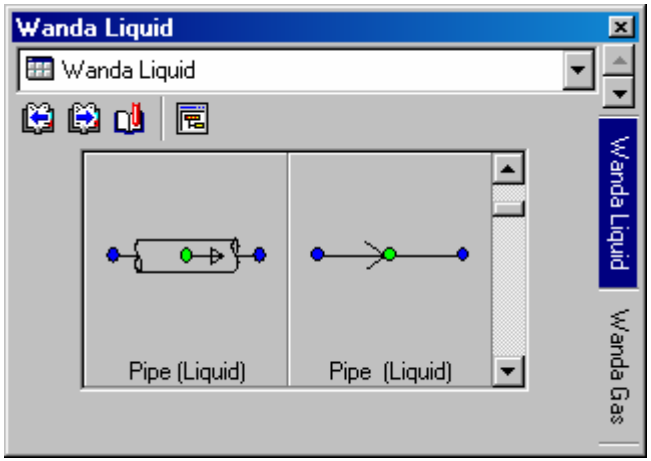
Wanda 4 Liquid – “all in one” PIPE

All PIPEs replaced by 1 new all-comprising type

REQUEST: water hammer PIPE with rectangular cross section



Two different (but familiar) symbols for the same model

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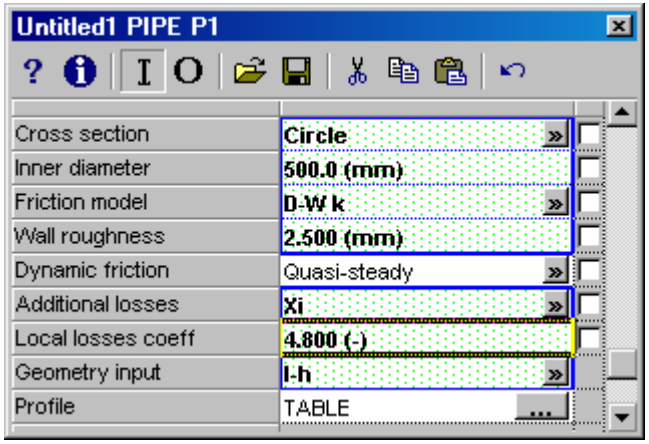
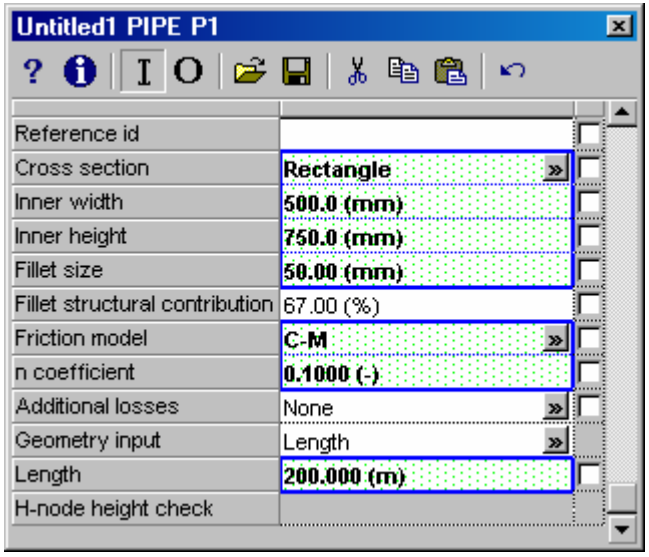
Wanda 4 Liquid – “all in one” PIPE

Choose input by drop-down list:

- Cross section:
  - **circle**
  - rectangle
- Friction model:
  - **Darcy-Weisbach k-value**
  - Darcy-Weisbach lambda-value
  - Chezy-Manning
  - Hazen- Williams





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Wanda 4 Liquid – “all in one” PIPE

Choose input by drop-down list (2):

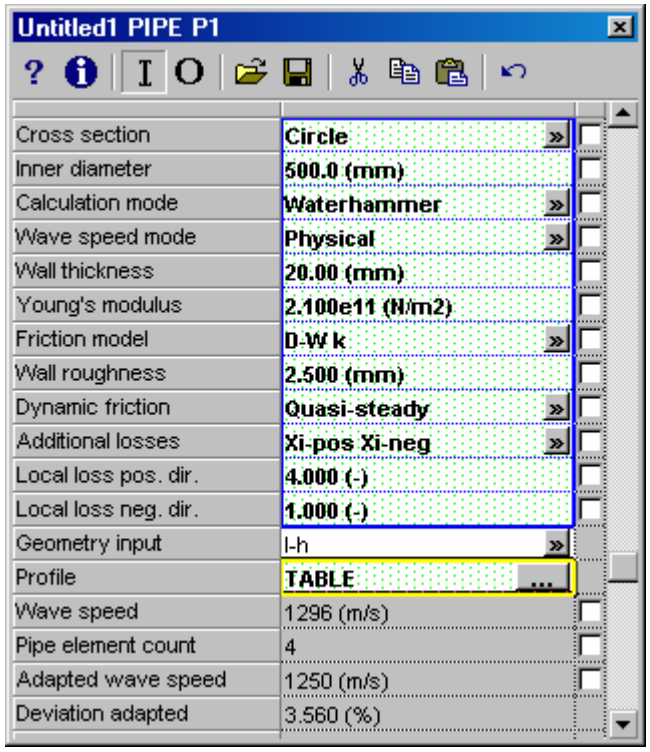
- Extra losses
  - **non**
  - Xi value (independent of flow direction)
  - Xi value Pos / Xi value Neg
  - Xi table
  - L_equivalent #D table
- Dynamic friction
  - **Quasi steady**
  - none

Wanda 4 Liquid – “all in one” PIPE

Choose input by drop-down list (3):

Solely in Transient mode

- Calculation mode
  - **Water hammer**
  - Rigid column
- Wave speed mode
  - **Physical**
  - Specified



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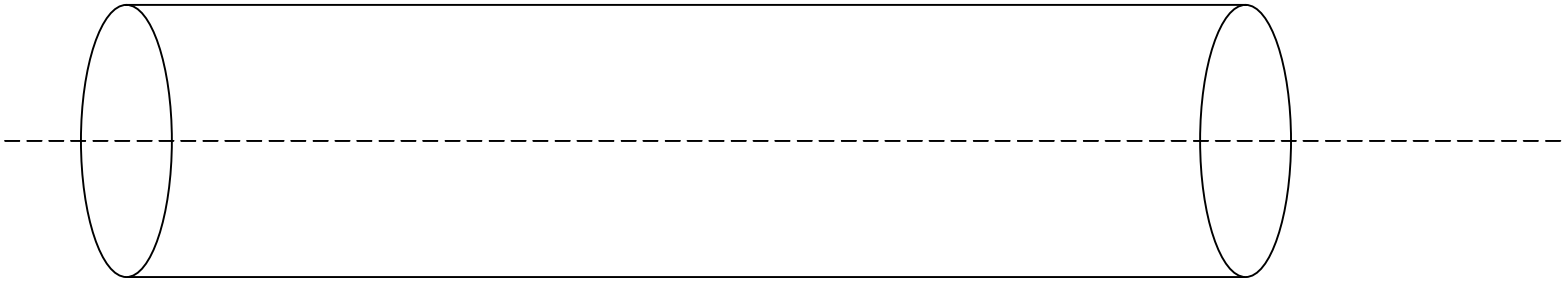
Wanda 4 Liquid – “all in one” PIPE

Change in definition of geometry / reference plane:

Wanda 3.7	upper inner side
Wanda 4	center line



For cavitation model the upper inner side is determining:

center line + ½ D

Min/Max pressure: with respect to center line

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Wanda 4 Liquid – “all in one” PIPE

All WANDA 3.7 models (en older) will be automatically converted to the new PIPE

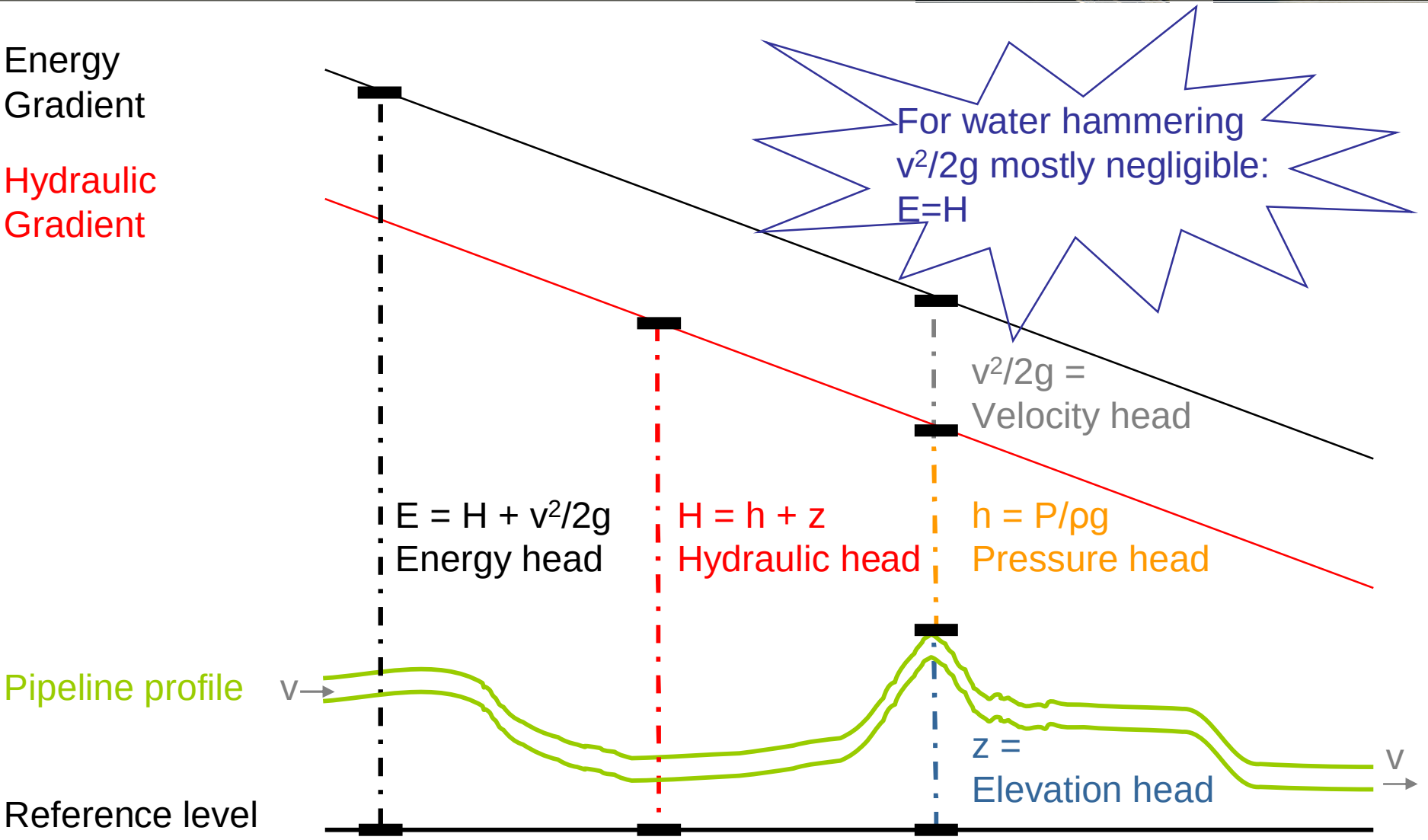
Input profiles will be shifted down by ½ D

Wanda 4 Liquid – H-node types

Several types of H-nodes:

- Standard — input: elevation for determination of pressure
- With demand: — extra input: Q or Q(t) table (replacing TAP)
- Init Head — for specification of head in isolated parts

Wanda 4 Liquid - elevation head



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Wanda 4 Liquid - elevation head

In WANDA 4 velocity head term **is** incorporated

Order of magnitude: $v = 1$ m/s $v^2/2g \approx$ 0,05 m

$v = 3$ m/s $v^2/2g \approx$ 0,46 m

Solely for those components for which the velocity is known (which excludes e.g. the PUMP)

Consequence: Pressure in WANDA 4 is somewhat lower than in WANDA3

(0,005 – 0,05 Bar ; 0,5 - 5 kPa)

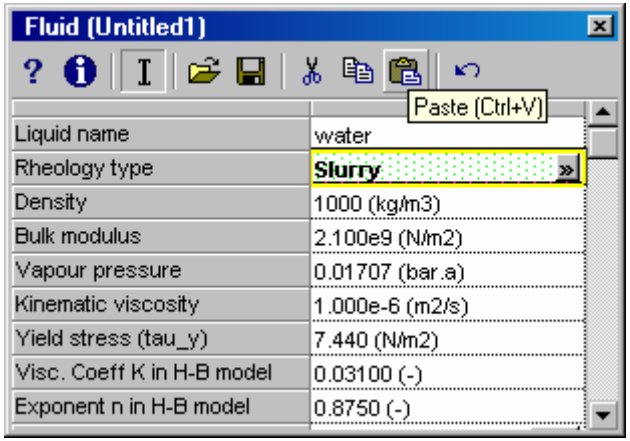
HEAD calculation remains UNCHANGED

Wanda 4 Liquid – Fluid window

NEW (Option): resistance model for slurries
(Non-Newtonian behavior)

Choice in Fluid window: **Newtonian** / Slurry

In case of a slurry: extra input parameters for Herschel-Bulkley model



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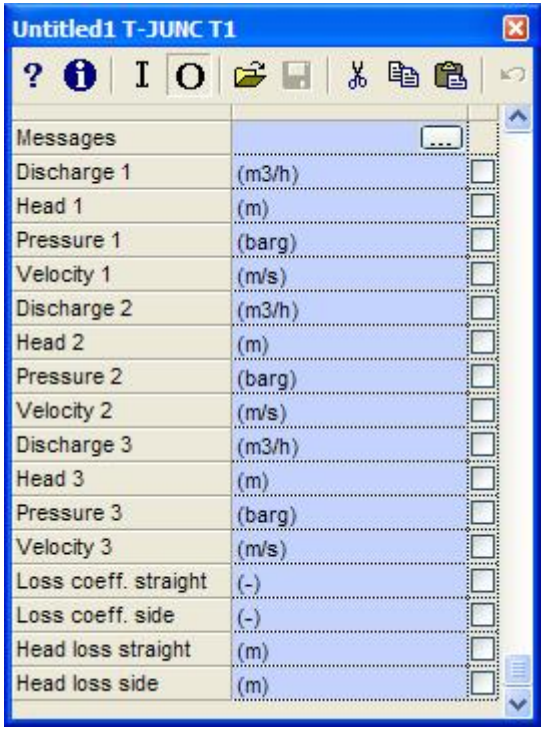
Wanda 4 Liquid – Output properties

Changed:

Order of output properties

Per connect node Q, H, P, v

(First: primary calculation variables,
Next: derived calculation variables)



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